Bioecology of Til Hawk Moth, *Acherontia styx* Westwood

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Abstract

The bioecology of til hawk moth, *Acherontia styx* Westwood was studied on *Sesamum indicum* (Linn.) variety TKG-22 under field and lab. condition during 2004-06. The eggs were globular in shape, yellow in colour with 0.70-0.95 mm in size. The incubation period of the eggs was 2-4 days with the neonate period of 10-15 minutes. There were five larval instars and length of the completely developed larva was 68-79 mm with larval period of 20-21 days. The maximum larvae were obtained during late August to September. The pre-pupal and pupal periods were 3-4 and 14-23 days respectively, with pupae conical in shape. The mating was always at morning (0.07-0.10 minutes) followed by oviposition (24 to 36 hours) with fecundity of 5-8. Life span of the adult was 3-5 days, total life cycle was completed in 39-52 days. Mean adult emergence (%), sex ratio and growth index were 95 to 100%, 1:1 and 2.64 to 2.27 respectively. There are only three generations in a year. The plants were infested to the extent of 31.6% by this insect. Maximum damage is caused during September-October.

Keywords: *Bioecology, Acherontia styx Westwood.*

Introduction

Sesame *Sesamum indicum* Linn. is the oldest indigenous oilseed crop of the world and also a major oilseed crop of India. This crop is attacked by 29 species of insect pests in different stages of its growth (Biswas *et al.,* 2001).

Til hawk moth, *Acherontia styx* Westwood is a sporadic pest but voracious feeder of sesame crop at larval stage. The larvae feed voraciously on leaves and defoliate the plants; and is capable of inflicting heavy damage at times. Only one larva is enough to denude the whole plant.

The present work is a novel approach in Bundelkhand Zone of Madhya Pradesh, which has not been studied before or explored elaborately. But, some work done on its bionomics has been reported by Mehta and Verma (1968), Lefroy (1990), Rai *et al.* (2001), Sharma and Choudhary (2005) and Atwal and Dhaliwal (2005). The present investigations conducted on different aspects of the bioecology of this insect are reported in this research paper.

Materials and Methods

Studies on the bionomics of til hawk moth, *Acherontia styx* Westwood were undertaken in the field in ambient conditions during July to December of 2004,2005 and 2006. For laboratory experiments, the cultivated sesame variety, TKG-22 and JT-7 were grown in glass jars. Full fed caterpillars were collected from the field of sesame crop and reared in glass jars and Petri dishes (7.5 cm diameter) on sesame leaves and fruiting bodies. The leaves/flowers were changed daily up to the second instar larval stage. Thereafter, buds, flowers, capsules and leaves were provided as food for the later larval stages. The matured larvae transform into pupae inside the bud and sometimes in deep dry soil available in fields, placed in glass jars/Petri dishes in the lab. Moths emerging from pupae were released in lantern globes containing cotton swabs dipped in 20% glucose solution. Sexes were examined by different morphological characters and moths were

kept under constant watch for studying mating, oviposition behaviour and egg laying.

Freshly laid eggs were counted and placed on fresh sesame leaves with the help of moist soft camel hairbrush. Observations were recorded on their colour, size, shape and incubation period. Duration of each larval instar, body segments and legs were recorded. Measurements of various stages were taken under the binocular with the help of ocular micrometer. However, advanced larval stages and pupae were measured with the help of Vernier callipers.

For adults, emerging from the above (the group being reared from freshly laid eggs), mating period, oviposition period, fecundity per female, pre pupal, pupal period of larvae and longevity of male and females were recorded.

Results and Discussion

The eggs (Fig.1a) are generally laid singly on the upper as well as lower surface of leaves. An adult female lives 3-5 days and lays only 3 to 8 eggs at different intervals, sometimes up to two days. Freshly laid eggs are greenish white in colour and measure 00.70 to 00.80 mm but they turn yellow during the incubation period when they grow to 00.90 to 00.95 mm (Table 3).

The incubation period varies from 02.00 to 04.00 days with subsequent hatching of eggs. The eggs are oval (1.2 x 1.5mm), shiny, smooth and pale green, changing to yellowish green just before hatching. Laid singly on the under and upper surface of leaves on peripheral twigs, usually hatching three to five days later (http:// www.styx.htm). The pale-yellow larvae emerge in 2-5 days reported by Rai *et al.* (2001); Sharma and Choudhary (2005); Atwal and Dhaliwal (2005). Year wise observation and the mean range is given in Table 3.

There are five larval instars in addition to the neonate larva, which is the newly hatched instar from the egg after completion of incubation. The neonate larva is a cylindrical white coloured instar with a conspicuous projection at the hind end of abdomen, referred as 'dunk'. This stage feeds on its own egg case in the beginning and after 10-15 minutes on the leaves. The nascent larva measures 03.50 to 04.00 mm x 00.35 to 00.50 mm whereas fully fed larva before moulting to the 1st instar grows to 04.50-05.00 mm x 00.60-00.70 mm. The dunk is white and measures 02.50-03.00 mm in full grown nascent larva, Table 3. After about 20 minutes the larva moults to 1st instar (Fig.1 b).

The first instar larva (Fig. 1c) is yellowish green in colour with black dunk and measures 09.00-12.00 x 01.00-01.50 mm. This larval instar persists for 115.00-130.00 hrs and when fully fed it measurers 18.00-22.00 x 02.00-02.40 mm with yellow green head and thorax; and dark green abdomen. Three pairs of thoracic legs on 1st-3rd thoracic segment and four pairs of prolegs on 6th-9th abdominal segments are observed. A fifth pair of prolegs is seen on the 13th abdominal segment. All legs are shiny brown in colour. The dunk, in this instar, is black and measures 02.90 to 03.00 mm. The larva feeds voraciously by scrapping on leaves but stops feeding some time before moulting to the next instar. Feeding and moulting period is shown in Table 2 and 3.

The second instar larva (Fig.1d) is also green in colour just as the first instar but the dunk changes to dark reddish black measuring 25.00-35.00 x 03.40-04.20 mm. This instar persists for 73.00-77.00 hrs and moults to the third instar. Before moulting, the fully fed larva measures 36.20-45.00 x 04.50-06.00 mm. The hook like dunk in this stage is dark reddish black and measures 05.50-06.00 mm long and has a width of 00.35-00.40 mm (Table 2 and 3). The legs develop minute black spots and this instar feeds on soft parts of branches in addition to leaves.

The third instar larva (Fig.1e) is quite big in size, 50.00-55.00 mm x 06.30-06.50 mm when newly moulted and 57.00-60.00 mm x 06.60-07.00 mm when fully fed. The dunk also grows accordingly and measures 06.50-07.00 mm x 00.45-00.50 mm (Table 3). The body colour is green with light yellow 'V' shaped marks on the abdomen and minute tubercles laterally on the terga. Thus this instar looks plump, decorated with a pleasant mixture of soft colours. It voraciously feeds on the leaves and branches and almost

entire plant is denuded within 24 hrs. (Fig.1o,p). It also feeds on pods. The third instar lasts for 74.40 to 77.30 hrs including the feeding (66.40 to 70.00 hrs) and moulting (06.40 to 07.30 hrs) periods (Table 5).

The fourth instar larva (Fig.1f) has the same body colour as the previous instar and measures 61.20-64.40 mm x 07.10-07.40 mm having a cylindrical shape. The dunk changes its colour to yellow and measures 08.00 mm x 00.52 to 00.60 mm in size (Table 2). The head looks like that of a grasshopper with blackish yellowgreen colour. One pair of spiracles is situated laterally on the thorax and seven pairs on abdomen (4^{th} to 10^{th} segments). The last pair of spiracles is seen on the 11^{th} segment. There are seven sharply defined yellow oblique lateral stripes on segments 5 to 11, each stripe edged above with dark blue region, sharply defined at the common edge but diffuse dorsad. Dunk is canary yellow, true legs black, prolegs and claspers green and anal flap green edged with yellow. Spiracles are oval, yellowish white with a central black slit, the whole bordered with brownish-green. The fourth larval instar lasts for 44.40-48.00 hrs including the feeding period of 34.40-40.00 hrs and moulting period of 08.00-10.00 hrs (Table 5). The fully fed larva before moulting is of 65.00-73.00 mm x 07.60-8.00 mm size (Table 2). This instar is a voracious feeder of leaves and only one larva is enough to denude the whole plant.

The fifth instar larva (Fig.1g) is again a colourful plump cylindrical creature as the earlier stage and measures 74.20-75.50 x 08.20-08.70 mm. Full fed caterpillar measures 77.20-82.00 x 09.00-10.00 mm with dark yellow dunk of 08.00-08.50 x 00.70-00.80 mm. The 5^{th} instar larval duration is 68.00-78.30 hrs including the feeding and pre pupation period (Table 3 and 5).

Mehta and Verma (1968); Lefroy (1990); Rai *et al.* (2001); Atwal and Dhaliwal (2005); and Sharma and Choudhary (2005) observed that the full grown caterpillar is bright green in colour with light oblique yellow strips on each side and a horn like process on hind end of the body, which measures about 90-100mm in length and 1cm in width, coinciding with the present study.

Cannibalism has been observed when the moth is reared in the laboratory and is quite frequent in the fifth instar, when more than one larva is reared in a Petri dish, one attacks the other (Fig.1h). The attack is made by the older larva. After some resistance the younger one is injured and fluid oozing out of the injured terga of thoracic region is sucked by the winner. Thereafter, the injured is completely consumed leaving only the head capsule along with the prothorax. Also, during moulting process, the exuviae are completely consumed by the moulted caterpillars.

The mean larval period varies from 19.75 to 19.99 days in field conditions. The larval period of first generations during 2004, 05, and 06 were 19.83±0.66, 19.99±0.51 and 19.75±0.19 days respectively (Table 4).

Larval period is usually long and may last two months or more reported by Mehta and Verma (1968); Lefroy (1990); Rai *et al,* (2001); Atwal and Dhaliwal (2005) but Sharma and Choudhary (2005) reported it to be of 14-21 days, which is in agreement with the present study.

Pre pupa (Fig.1i), full-grown last/fifth instar larva stops feeding and burrows in 04.00-6.00 cm deep funnel in soil with head forwards. It forms an oral cell for pupation, shrinks in size and curves to a semilunar shape. Then abdominal and thoracic legs are lost and finally the head capsule is casted out and a pre pupa is formed. It is conical, dark yellowish green coloured measuring 40.00-41.00 x 05.00-05.30 mm (Table 3). The pre pupal duration varied in the three years of study and is found to be 78.00, 86.00 and 79.30 hrs for 2004, 05, and 06 respectively (Table 5).

At the end of this period a conical, soft, shining blood red coloured pupa is formed with two black eyes on the anterior end, which is the head region (Fig. 6j,k). Abdomen is distinctly marked in 9 segments, the terminal segment ending into a spine like structure. Sexual dimorphism can be seen in the pupa by the presence of genital and anal pores in the 8^{th} and 9^{th} segments respectively in male and on 7^{th} and 9^{th} segments in the female. The pupal duration ranges from 14.00 to 23.00 days (Table 3). According to Lefroy (1990); Rai

al., (2001); Atwal and Dhaliwal (2005); Sharma and Choudhary (2005), the full grown larvae burrow about 15cm deep in the soil and form an oval cell for pupation. The pupal period lasts for 15-21days in summer, coinciding with the present study. Larval and pupal developmental period (A) is recorded to be 32.85-43.65 days (mean 38.12±1.89 days) (Table 3).

The Adult moths are large, robust thick set with a wing span of 34.90 to 39.90 mm. These moths are commonly known as hawk moth, sphinx moth or death's head moth based on structural and behavioral characteristics. Adult hawk moths are also, called "robbers of honey" because they rob honey from honeycomb. The moths are swift fliers and often make hawk like darts to a source of light at dusk. The forewing of moth is decorated with a mixture of dark mottled brown and grey patterns with dark or black wavy markings and a prominent yellow spot on each wing. The abdomen is yellow in colour, hind wings are yellow greyish with black marks and large vertical line. The pro thorax carries a characteristic whitish and reddish brown mark, which appears like a human skull.

A pair of large, black and transparent eyes and a pair of spring like thin antennae are present on the lateral sides of head of both sexes. Male adults measure 30.00 to 30.02 mm (mean 30.00±0.0047 mm) in length and 34.00 to 35.02 mm (mean 34.90±0.21 mm) in width with an expanded wing (both wing span about 7 cm). Females are longer, being 37.05 to 38.00 mm (mean 37.72±0.24 mm) in length and 39.00 to 40.02 mm (mean 39.90±0.21 mm) in width with an expanded wing (both wing span about 8 cm) (Table 3). Males are smaller than the females. The sexes are identified by the presence of shiny greyish tuft on thorax with one pair of black dots in males. Females are larger in width and have shining reddish grey tuft like a human skull on the thorax (Fig.1m,n). Mehta and Verma (1968); Atwal and Dhaliwal (2005); Sharma and Choudhary (2005) have also recorded similar features in adults.

The adult emergence (B) percentage was 95 to 100, 98 to 100 and 92 to 100 (mean range 95 to 100 ± 0.87 percent) during the 3 consecutive years of study respectively. Moths emerged from pupae during night with male and female sex ratio of 1:1.

Male and female moths after emergence, rest for a while on branches and soil and then undertake short flights in search of food. Next night again, the male moths undertake flight, first in search of food for 2.00-4.00 hrs and then engage in characteristic high speed directed flights in search of pheromone plumes. During this time females are inactive, releasing pheromones only. Pre mating period has been recorded as 21.00 to 24.00 hrs (mean 22.70±1.13 hrs). The mating is complete within 00.07 to 00.10 minutes (mean 0.087±0.0057 minutes) as shown in Table 3.

After mating, the pre oviposition period is 11.00 to 15.00 hrs (mean 12.45±1.53 hrs). Oviposition period (egg laying time) ranges between 24.00 to 36.00 hrs (mean 27.60±4.73 hrs.) with post oviposition period of 01.50 to 03.00 days (mean 02.12±0.46 days). During oviposition period the female moth lays eggs singly on the leaves. Eggs are laid in early mornings only. Fecundity per females has been found to be 05.00 to 08.00 eggs (mean 06.49±0.72) during all three seasons of study (Table 3).

Longevity of males and females ranged from 02.00 to 03.00 days (mean 02.56±0.16 days) and 03.00 to 05.00 days (mean 3.76±0.39 days) respectively (Table 3).

Growth index (B/A) was found to be 02.79 to 02.38, 02.27 to 02.65 and 02.49 to 02.17 in three consecutive years respectively (Mean range 02.27 to 02.64±0.078).

Total Life span of adult from egg laying to adult stage was completed in 38.92 to 39.14 days during all three seasons of study (Table 4). One generation was completed during August to October each year of study. Similar, results were reported by Mehta and Verma (1968); Atwal and Dhaliwal (2005); and Sharma and Choudhary (2005).

Nature and extent of damage: Maximum percent damage to flowers caused by larvae of *Acherontia* was 31.6% during late September (38th standard meteorological week) and minimum (3.8%) at begining of September (34 S.M.W.) (Fig. 2).

The percent damage of flower is positively correlated with the maximum temperature but negatively correlated with the minimum temperature, relative humidity and rainfall (Table1).

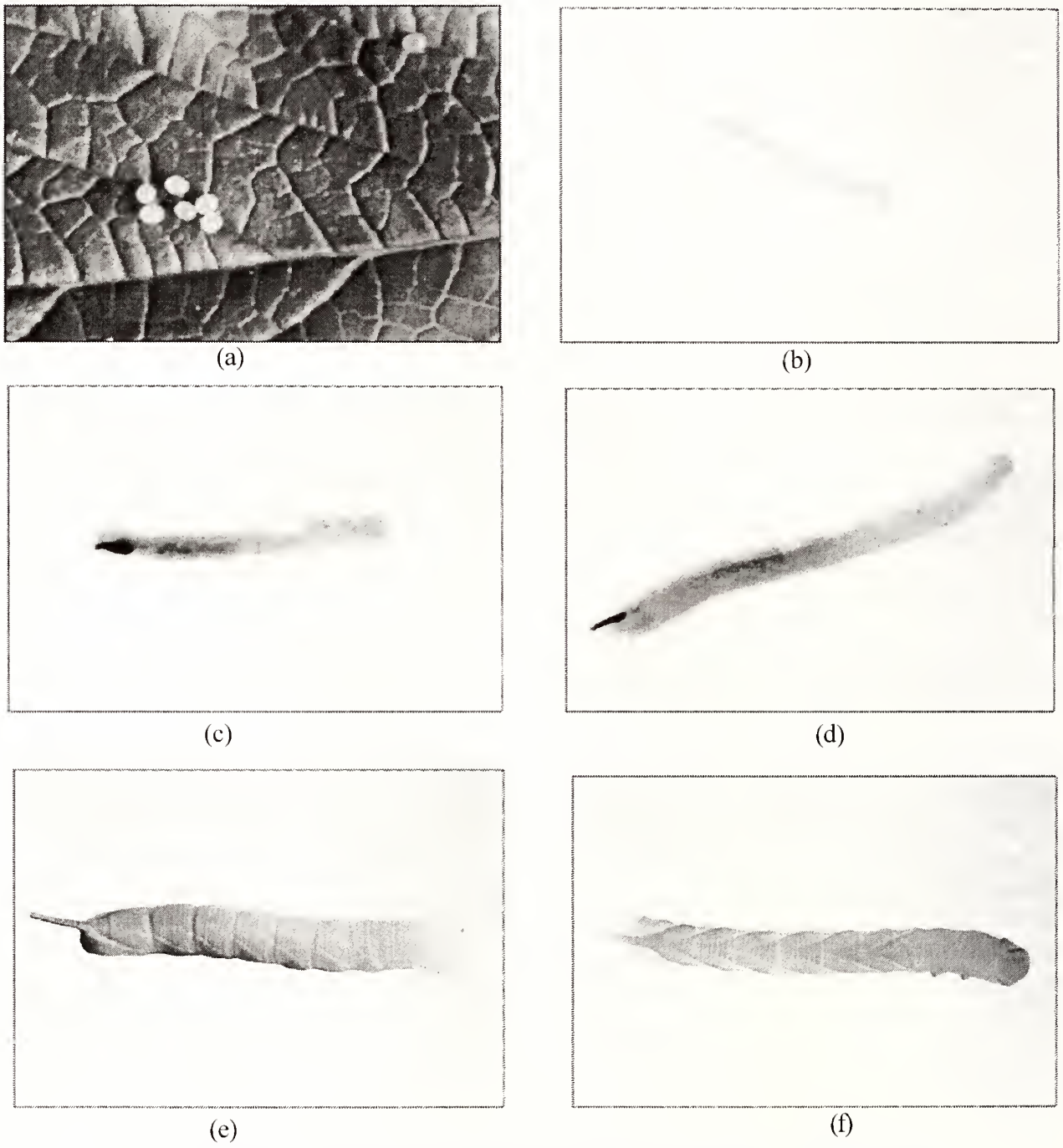
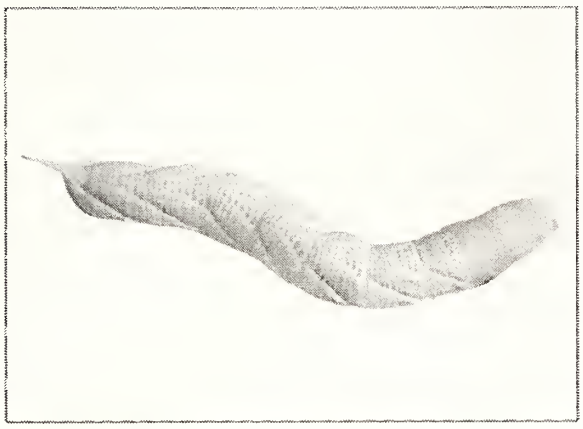


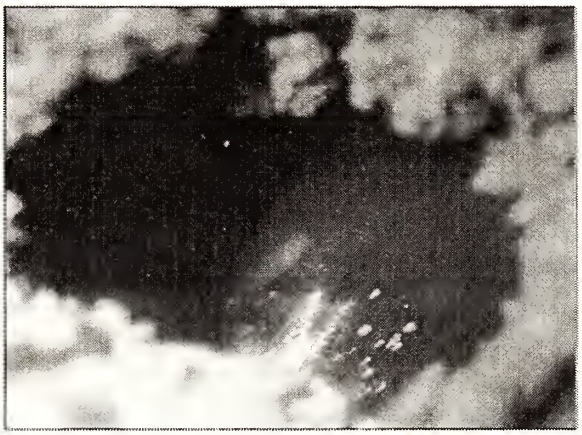
Fig. 1: (a) Eggs of *Acherontia styx* Westwood (b) Neonate larva (c) First instar larva (d) Second instar larva (e) Third instar larva (f) Fourth instar larva



(g)

(h)

(i)

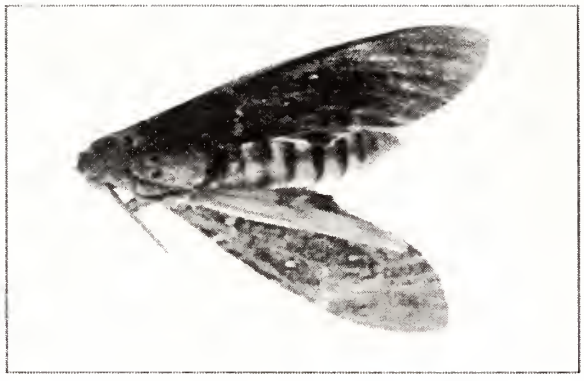


(j)

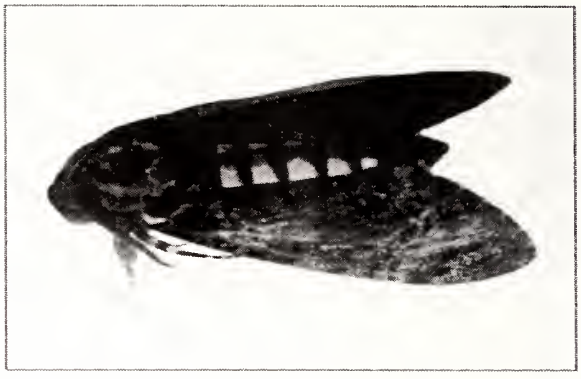
(k)

(l)

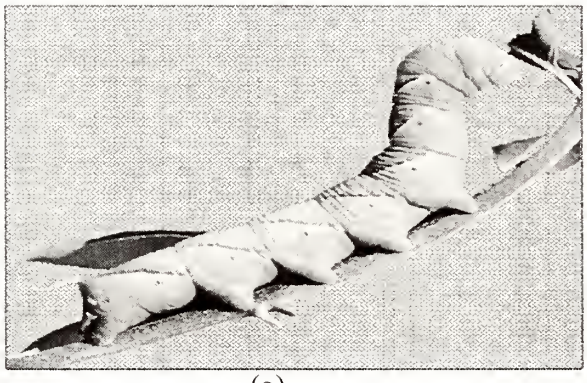
Fig. 1: (g) Fifth instar larva (h) Cannibalism (i) Fifth instar larva enterning in soil for pupation (j) Pupa in the earthen cell (k) Male and female pupae (l) Male and female adult emerging from pupae



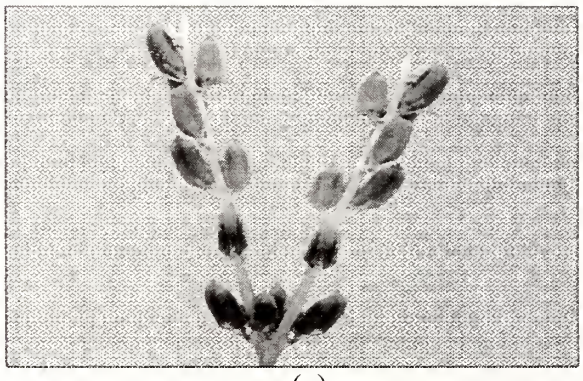
(m)



(n)



(o)



(p)

Fig. 1: (m) Male adult (n) Female adult (o) Larva of *Acherontia styx* devouring leaves (p) Plant damaged by larva of *Acherontia styx*

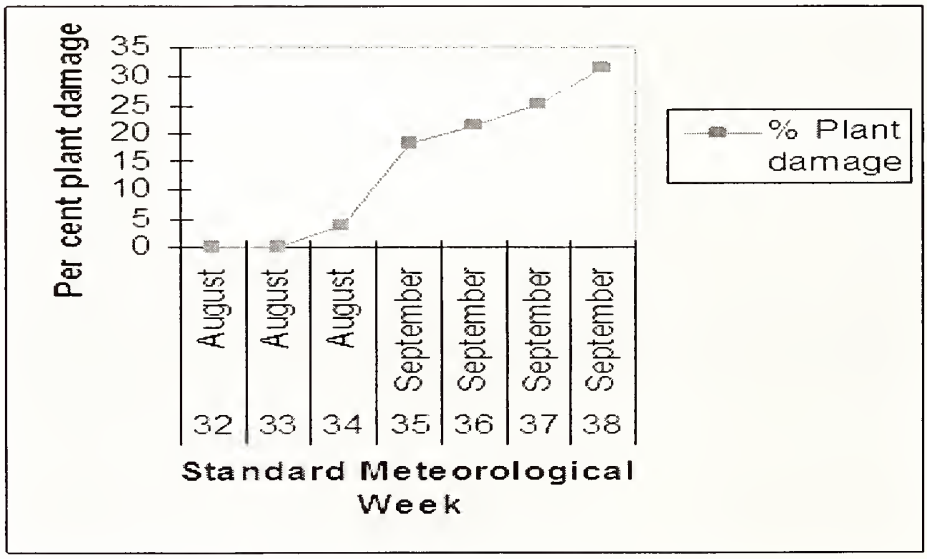


Fig. 2: Mean per cent damage of flowers caused by *Acherontia styx*

Table-1: Correlation coefficient between per cent damage of plant and weather parameters

Weather Parameters	*Acherontia larvae*
MaximumTemperature (°C)	0.840957*
MinimumTemperature (°C)	-0.43453
RelativeHumidity (%)	-0.85999
Rainfall (mm)	-0.55669

*Significant@ 0.05 probability

Table-2: Mean*(±SEM) size of egg to larval stage of *Acherontia styx* Westwood during 2004-06

Stage		Length (mm)		Width (mm)	
		Range	Mean*±SEM	Range	Mean*±SEM
Egg	Fresh	-	-	0.70-0.80	0.78±0.023
	Matured	-	-	0.90-0.95	0.91±0.018
Neonate larva	Young	3.50-4.00	3.80±0.097	0.35-0.50	0.45±0.018
	Full fed	4.50-5.00	4.58±0.129	0.60-0.70	0.67±0.032
	Dunk	2.50-3.00	2.59±0.052	0.20-0.28	0.23±0.013
1st instar larva	Young	9.00-12.00	10.40±0.91	1.00-1.50	1.19±0.13
	Full fed	18.00-22.00	20.00±0.71	2.00-2.40	2.30±0.082
	Dunk	2.90-3.00	2.96±0.045	0.25-0.30	0.29±0.012
2nd instar larva	Young	25.00-35.00	29.20±3.74	3.40-4.20	3.74±0.35
	Full fed	36.20-45.00	39.72±1.73	4.50-6.00	4.92±0.26
	Dunk	5.50-6.00	5.90±0.13	0.35-0.40	0.38±0.012
3rd instar larva	Young	50.00-55.00	53.75±1.60	6.30-6.50	6.41±0.051
	Full fed	57.00-60.00	58.00±0.66	6.60-7.00	6.63±0.088
	Dunk	6.50-7.00	6.85±0.13	0.45-0.50	0.49±0.012
4th instar larva	Young	61.20-64.40	62.85±0.85	7.10-7.40	7.24±0.102
	Full fed	65.00-73.00	68.50±1.10	7.60-8.00	7.84±0.14
	Dunk	7.60-8.00	7.90±0.10	0.52-0.60	.57±0.0066
5th instar larva	Young	74.20-75.50	74.73±0.30	8.20-8.70	8.52±0.12
	Full fed	77.20-82.00	78.52±0.98	9.00-10.00	9.55±0.47
	Dunk	8.00-8.50	8.29±0.052	0.70-0.80	0.74±0.046

*Mean of 10 individuals

Table-3: Life span (mean*± SEM) of Acherontia styx Westwood and size (mean*± SEM) of different developmental stages derived from observations during 2004-06

Parameters	Period Range			Size Range (mm)		
	Range	Mean* ± SEM	Length	Mean *± SEM	Width	Mean* ± SEM
Egg (Incubation)	02.00-04.00	03.18±0.33 (D)	-	-	00.70-0.95	00.82±0.089
Larval stage						
Neonate larvae	00.17-00.20	00.18±0.073 (M)	03.50-5.00	04.20±0.38	00.35-0.70	00.50±0.028
I instar	115.30-130.00	125.62±3.56 (H)	09.00-22.00	15.35±3.43	01.00-2.40	01.55±0.36
II instar	73.40-77.00	74.72±0.89 (H)	25.00-45.00	34.36±7.86	03.40-6.00	04.39±0.68
III instar	73.40-75.20	74.53±0.40 (H)	50.00-60.00	54.95±3.80	06.30-7.00	06.61±0.20
IV instar	44.30-49.00	46.44±0.84 (H)	61.20-73.00	67.29±2.80	07.10-8.00	07.43±0.14
V instar	68.00-78.30	73.43±0.30 (H)	74.20-82.00	78.59±2.53	08.20-10.00	08.14±0.30
Pre-pupa	78.00-86.00	81.43±1.90 (H)	40.00-41.00	40.20±0.26	05.00-5.30	05.04±0.046
Pupa	14.00-23.00	17.61±1.56 (D)	40.00-44.00	41.00±0.71	09.00-9.20	09.04±0.046
Developmental period (Larva & Pupa)-A	32.85-43.65	38.12±1.89 (D)	-	-	-	-
Adults						
Male	02.00-03.00	02.56±0.16 (D)	30.00-30.02	30.00±0.0047	34.00-35.02	34.90±0.21**
Female	03.00-05.00	03.76±0.39 (D)	37.05-38.00	37.72±0.24	39.00-40.02	39.90±0.21**
Pre mating	21.00-24.00	22.70±1.13 (H)	-	-	-	-
Mating	00.07-00.10	00.087±0.005 (M)	-	-	-	-
Pre-oviposition	11.00-15.00	12.45±1.53 (H)	-	-	-	-
Oviposition	24.00-36.00	27.60±4.73 (H)	-	-	-	-
Post oviposition	01.50-03.00	02.12±0.46 (D)	-	-	-	-
Total Life Span	39.00-52.00	44.44±3.17 (D)	-	-	-	-

*Mean of 10 individuals; ** : Width of wing span; D :Days; H : Hours; M : Minutes

Table-4: Mean duration (days)*±SEM of developmental stages and the total life span of *Acherontia styx* Westwood (First generation only) during 2004-06

Period of Study		Incubation Period	Larva	Pupa	Adult	Total Life Span
From	To					
27/08/04	10/10/04	2.91±0.23	19.83±0.66	14.43±0.14	1.990.045	39.10±0.037
25/08/05	03/10/05	2.90±0.22	19.99±0.51	14.32±0.031	1.99±0.048	39.14±0.051
01/09/06	12/10/06	2.92±0.20	19.75±0.19	14.43±0.12	1.99±0.052	38.92±0.212

*Mean of 10 individuals

Table-5: Mean duration (hours)*±SEM of feeding (F)and moulting (M) in larval instars of *Acherontia styx* Westwood (First generation only) during 2004-06

Year of Study/ Generation	First instar			Second instar			Third instar			Fourth instar			Fifth instar		
	F	M	T	F	M	T	F	M	T	F	M	T	F	PP	T
2004	120.10 ±0.95	9.10 ±1.00	129.20 ±1.95	66.00 ±0.68	08.00 ±0.90	74.00 ±1.58	68.00 ±0.91	06.40 ±0.57	74.40 ±1.48	34.40 ±1.22	10.00 ±0.75	44.40 ±1.97	68.35 ±0.98	78.00 ±0.21	146.35 ±1.19
2005	117.00 ±0.87	10.00 ±0.90	127.00 ±1.77	64.00 ±1.20	09.40 ±0.71	73.40 ±1.91	70.00 ±0.34	07.30 ±0.80	77.30 ±1.14	40.00 ±1.00	08.00 ±0.33	48.00 ±1.33	78.30 ±0.79	86.00 ±1.05	164.30 ±1.84
2006	121.30 ±0.91	10.30 ±1.15	122.00 ±2.06	68.30 ±1.00	08.30 ±0.83	75.00 ±1.83	66.40 ±1.12	07.20 ±0.25	74.00 ±1.37	38.00 ±0.84	09.30 ±0.49	47.30 ±1.33	75.79 ±0.89	79.30 ±0.72	154.70 ±1.61

*Mean of 10 individuals; F : Feeding duration; M : Moulting duration; PP : Prepupal period; T : Total hours of instar

References

Atwal, A.S. and Dhaliwal, G.S. 2005. Pests of Oilseed Crops. Agricultural Pests of South Asia and Their Management. 229-231.

Biswas, G.C., Kabir, S.M.H. and Das, G.P. 2001. Insect pest of sesamum (Sesamum indicum Linn.) in Bangladesh, their succession and natural enemies. Indian Journal of Entomology 63: 117-124.

Lefroy, H.M. 1990. Indian Insect Pest. New Delhi: Today & Tomorrows Printers and Publishers.

Mehta, P.R. and Verma, B.K. 1968. Plant Protection. Directorate of Extension, Ministry of Food & Agriculture, India.

Rai, H.S., Gupta, M.P. and Verma, M.L. 2001. Insect pests of sesame and their integrated management. Indian farming 30-32.

Sharma, S. and Choudhary, A. 2005. Introductory Agriculture Entomology. New Delhi: Mahamaya Publishing House.

Shingidae of the Eastern Palaearctic–*Acherontia styx* (Westwood, 1847). Accessed online at http:// www.styx.htm (04/06/2007).